Dick, Here are Mitch's optimized set up instructions as we discussed. See you in Chicago Best, Sonj

Alignment Proceedure for Minimum Lateral Tracking Error Adjustment of Offset Pickup Arms

Reference is made to the attached drawing for definitions and to assure that the correct measurement is performed. The proceedure described deals with the real situation presently found in the audio equipment available at all price levels at the time of this memorandum (April 1977). None of the arms we have seen are of the correct offset angle design nor are the best instructions given for obtaining the optimum performance in each case given the design deficiencies.The purpose of this memo is to permit each case to be fully optimized in spite of the apparent deficiencies of the designs. In order to accomplish this it is necessary to twist the pickup in the mounting whether a demountable head shell or a fixed head arm. It is also necessary to be able to set the pickup to the optimum overhang in order for the approa to work. So, determine just how this will be possible in each case before starting the proceedure. Many arms permit the pickup to slide back and forth in the shell, and the arm mounting base in the case of the separate arm/TT systems can also be varied in position. The basic parameter that determines the setup conditions is the "effective arm length". Consult Fig 1. Note that this is the length of the arc that the stylus swings on as the arm moves across the record. This length should be measured carefully with a precision rule as an error of less than 0.02 inch should be obtained. We recommend that two narrow flexible machinists scales be used for this. The Starrett 6" type C305R and the 12" C316R are quite good for this use.The ruling is fine enough to serve being in .01 and .1 inch graduations.

Step 1: Mount the pickup not fully tightened and measure effective arm length. (see fig 1).

Step 2: Consult the graph- fig 4- to find the optimum overhang for that length arm. Measure the overhang by swinging the arm over the center pin and using the small rule find the overhang that exist in the starting setup.Some arms are easily raised to make it eas to do this without a large error from having to lift the arm too far from the position in which it will track on the record. It is convenient to use the distance from the edge of the center-p since the diameter of 0.282 to 0.284 is the common range of use. This allows the arm be lifted just enough to clear the pin and makes it possible to position the rule so that it is easily read from the side. It is simple to deduct the 0.142" from the value to be used and read it as the stylus just crosses over the rule in line with the arm pivot point at the center pin. It will in most cases be necessary to go back and forth several times to obtain the correct settings since the effective length may be changed by the adjustment. Note from fig 4 that the opt. overha changes very little as the arm length alters but the offset angle changes rapidly. The perfection of all the following efforts and the final result depend upon getting the overhang correct for th actual working arm length. Do not at this point be concerned wit the offset angle but try to get the overhang correct and to measure the effective arm length accurately.

Step 3; Construct and retain for future use a 5x7 file card ruled as shown in fig2. The hole for the center pin can be made by starting it with a sharp pencil and pressing it over the centerpin. The radial line and the two perpendicular lines should line up with the center pi center. These two record groove radii are the positions that have zero tracking error laterally for all arm lengths. The zero error points are derived from the inner and outer diameter dimensions of the record thus are independent of the arm size. Using this fact it is possible to correctly adjust the offset angle of the previously set up arm so that the optimum and minimum tracking error distortion will be achieved. The arm can be positioned as though to play a record -by the cueing lever if possible- just over the outer (4.76") mark and by sighting the pickup to get it by twisting to lie on a line that is perpendicular to the radial line intersecting the stylus at the zero error points. After the pickup is set to the outer zero, try it at the inner point (2.60"). With some pickups that have a flat front face it is possible to sight and to test with the small rule to see that the face lines up parallel to the radial line.One such pickup is the Denon 103. It is easy to observe the position of the center pin using the front face of this pickup as a "gun-sight" noting that the sight line should be to a point just past the center pin's center by the same distance that the face is in front of the stylus. A little experience with this approach will readilly develop the ability to set up quickly to the optimum. Avoid allowing the stylus to touch the surface of the card to prevent bending it if the table is rotated backwards during the handling.When correctly set up the actual error angle is greatest at the outer record diameter and each of the other two maximum errors (in angle) are progressively less. This is because the distortion that is produced by the error increases as the groove speed decreases towards the inner grooves. It is directly proportional to the angle divided by the groove speed.Thus the degrees error per inch of groove radius is equal at the three maximum error points and is also minimum in magnitude for the available arm length.

Step4 : To set up the skating force compensation to the ideal value it is only necessary to play a relatively low level record passage and to raise and lower the stylus from the grooves while watching closely to see that the stylus remains centered in the same position in the pickup when in the playing position as in the raised position. The adjustment is important because of the free compliance of the stylus and the fact that it is of only a few millimeters length allow it to move a very considerable angle from any steady skating force that is allowed or from too much compensation. Such an error causes the alignment to err and defeats the adjustment as well as the effects of the unbalanced force on the two groove walls.

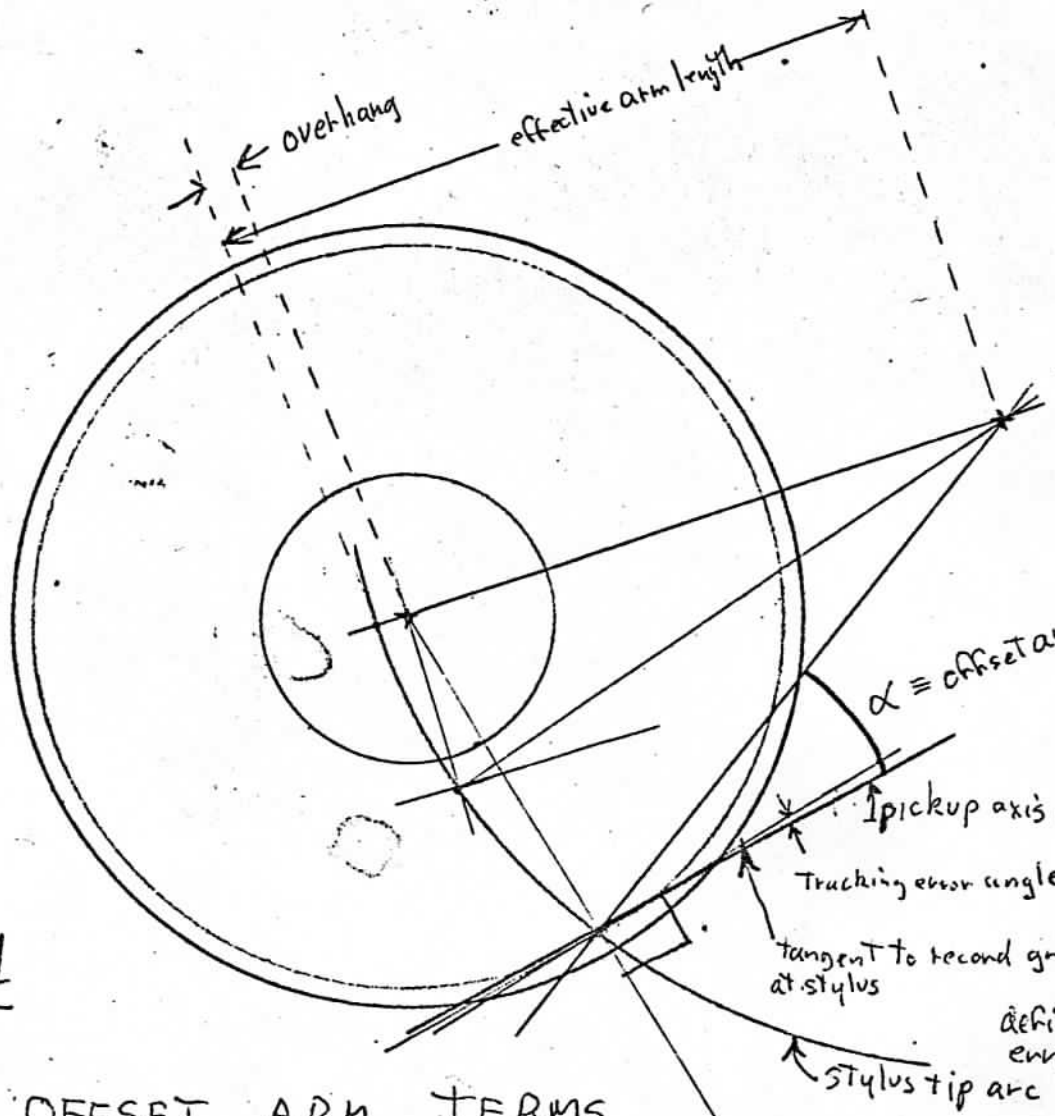


Fig 1

OFFSET ARM TERMS

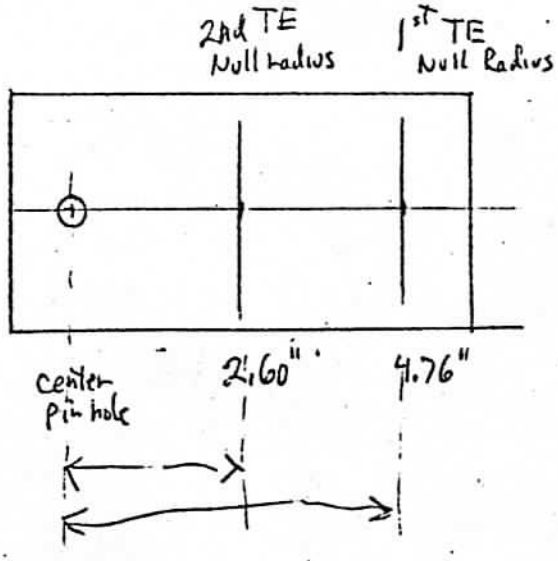


Fig 2

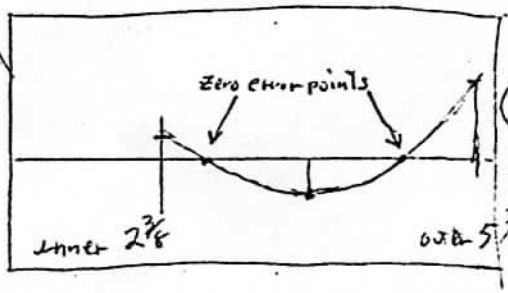
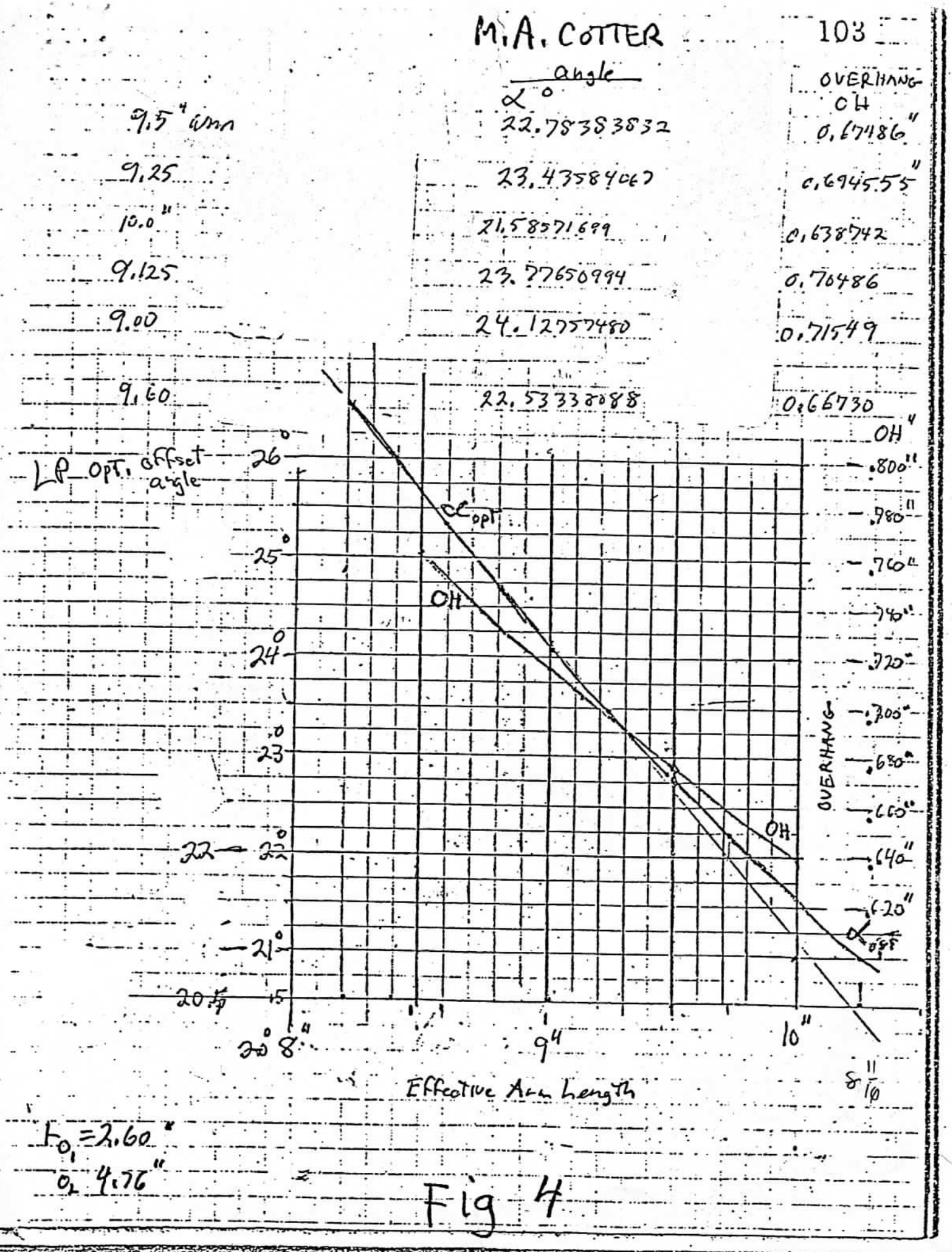


Fig 3

std center pin diameter .282" / .284

TEST CARD for checking system setup. Place the card over the center pin to align. The pickup angle of offset for zero error at these two radii (in step 3 of instructions)

M. A. COTTER



$L_{O_1} = 2.60"$

O_2 4.76"

Fig 4

Table of Optimum Overhang and Offset Angle Alignments for Pivoted Tone Arms

Optimized for a 12-inch LP record with a recorded area between the IEC Standard maximum and minimum radii of 146.050 mm (5.750 in) and 60.325 mm (2.375 in). Zero tracking error in all cases at radii of 120.90 mm (4.76 in) and 66.04 mm (2.60 in). For in-between values of arm length, interpolation error will be smaller than the least possible measurement error.

Effective Arm Length		Optimum Overhang		Optimum Offset Angle	Effective Arm Length		Optimum Overhang		Optimum Offset Angle
mm	(in)	mm	(in)	°	mm	(in)	mm	(in)	°
200	(7.874)	21.055	(0.829)	27.854	238	(9.370)	17.398	(0.685)	23.118
201	(7.913)	20.938	(0.824)	27.704	239	(9.409)	17.319	(0.682)	23.061
202	(7.953)	20.822	(0.820)	27.555	240	(9.449)	17.241	(0.679)	22.914
203	(7.992)	20.708	(0.815)	27.408	241	(9.488)	17.164	(0.676)	22.814
204	(8.031)	20.595	(0.811)	27.262	242	(9.528)	17.088	(0.673)	22.714
205	(8.071)	20.483	(0.806)	27.118	243	(9.567)	17.012	(0.670)	22.616
206	(8.110)	20.373	(0.802)	26.976	244	(9.606)	16.937	(0.667)	22.518
207	(8.150)	20.264	(0.798)	26.835	245	(9.646)	16.863	(0.664)	22.421
208	(8.189)	20.156	(0.794)	26.696	246	(9.685)	16.790	(0.661)	22.325
209	(8.228)	20.049	(0.789)	26.558	247	(9.724)	16.717	(0.658)	22.230
210	(8.268)	19.944	(0.785)	26.422	248	(9.764)	16.644	(0.655)	22.135
211	(8.307)	19.839	(0.781)	26.287	249	(9.803)	16.573	(0.652)	22.042
212	(8.346)	19.736	(0.777)	26.153	250	(9.843)	16.502	(0.650)	21.949
213	(8.386)	19.634	(0.773)	26.021	251	(9.882)	16.431	(0.647)	21.857
214	(8.425)	19.533	(0.769)	25.891	252	(9.921)	16.362	(0.644)	21.766
215	(8.465)	19.433	(0.765)	25.762	253	(9.961)	16.293	(0.641)	21.675
216	(8.504)	19.332	(0.761)	25.634	254	(10.000)	16.224	(0.639)	21.586
217	(8.543)	19.237	(0.757)	25.507	255	(10.039)	16.156	(0.636)	21.497
218	(8.583)	19.140	(0.754)	25.382	256	(10.079)	16.089	(0.633)	21.409
219	(8.622)	19.044	(0.750)	25.258	257	(10.118)	16.022	(0.631)	21.321
220	(8.661)	18.949	(0.746)	25.135	258	(10.157)	15.956	(0.628)	21.235
221	(8.701)	18.856	(0.742)	25.013	259	(10.197)	15.890	(0.626)	21.149
222	(8.740)	18.763	(0.739)	24.893	260	(10.236)	15.825	(0.623)	21.064
223	(8.780)	18.671	(0.735)	24.774	261	(10.276)	15.761	(0.621)	20.979
224	(8.819)	18.580	(0.731)	24.656	262	(10.315)	15.697	(0.618)	20.895
225	(8.858)	18.490	(0.728)	24.539	263	(10.354)	15.633	(0.615)	20.812
226	(8.898)	18.401	(0.724)	24.423	264	(10.394)	15.570	(0.613)	20.730
227	(8.937)	18.313	(0.721)	24.309	265	(10.433)	15.508	(0.611)	20.648
228	(8.976)	18.225	(0.718)	24.195	266	(10.472)	15.446	(0.608)	20.567
229	(9.016)	18.139	(0.714)	24.083	267	(10.512)	15.384	(0.606)	20.486
230	(9.055)	18.053	(0.711)	23.971	268	(10.551)	15.324	(0.603)	20.406
231	(9.094)	17.969	(0.707)	23.861	269	(10.591)	15.263	(0.601)	20.327
232	(9.134)	17.885	(0.704)	23.752	270	(10.630)	15.203	(0.599)	20.248
233	(9.173)	17.801	(0.701)	23.644	271	(10.669)	15.144	(0.596)	20.170
234	(9.213)	17.719	(0.698)	23.537	272	(10.709)	15.085	(0.594)	20.093
235	(9.252)	17.638	(0.694)	23.431	273	(10.748)	15.026	(0.592)	20.016
236	(9.291)	17.557	(0.691)	23.325	274	(10.787)	14.968	(0.589)	19.940
237	(9.331)	17.477	(0.688)	23.221	275	(10.827)	14.911	(0.587)	19.865